

### 3.5. Family SYRPHIDAE

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Small to large, very slender to robust flies (Figs 1–2), 4–25 mm long. Body usually black, very often with yellow or orange markings on head and thorax and particularly on abdomen, more rarely predominately brown, yellow metallic green, or blue, or with various combinations of these or other colours. Integument usually smooth but sometimes partly or totally punctate, sculptured, or rugose, usually nearly covered with dense short pile, rarely with long pile or nearly bare; pile sometimes flattened or scale-like and forming dense tomentum, or on thorax strong and bristlelike; both pilose and bare areas shining, slightly to densely pollinose, or with very short dense microtrichia. Many species excellent mimics of aculeate Hymenoptera.

**Adult.** Head: usually holoptic in male, although sometimes very narrowly to broadly dichoptic, moderately to broadly dichoptic in fe-

male, without bristles. Some or all facets of upper part of eye sometimes enlarged in male; eye usually unicolorous, rarely with dark spots or bands, or with irregular markings, bare or with very short and sparse to long and dense pile; these pili rarely scale-like; three ocelli present. Facial profile varied, sometimes sexually dimorphic (Figs 3–20, 64–69, 80–88); see Thompson (1972) for discussion. Mouthparts variable in length, usually correlated with length of subcranial cavity; taxonomic significance of variation unknown. Antenna sometimes borne on a short or long frontal prominence (Figs 12, 64, 86, 88); scape and pedicel subcylindrical but varying greatly in length with pile or setae; basoflagellomere varying greatly in shape, and often with a distinct sensory pit on lower part of inner surface; arista usually with two aristomeres but sometimes with three, usually dorsal but sometimes subapical or apical, usually longer than ba-

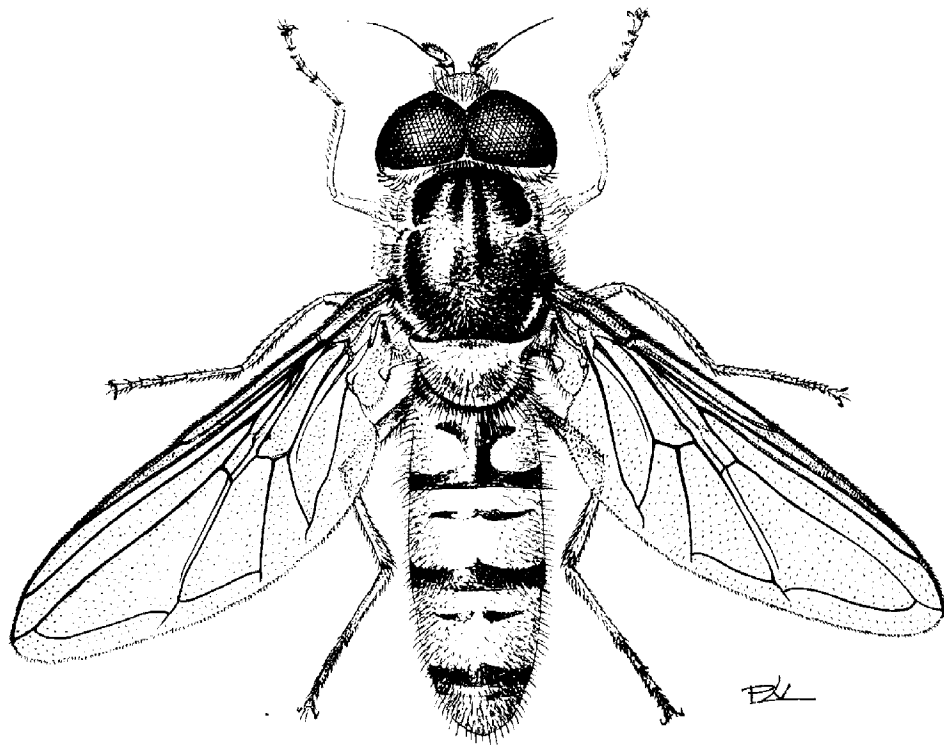


Fig. 5.1. *Episyrphus balteatus* (De Geer), male.

soflagellomere but very short in some Microdontinae and in some groups with apical arista, usually bare or with short pile, sometimes short to long plumose, rarely appearing strap-like because of very dense pilosity; antennal sockets confluent or separated. Lower facial margin usually with distinct median notch (Fig. 84), more rarely evenly rounded (Fig. 83). Frontogenal suture usually elongate, extending from anteroventral angle of eye for one-third or sometimes up to two thirds distance to antennal base (Fig. 84), rarely reduced to an elongate anterior tentorial pit at anteroventral margin of eye (Fig. 83); face usually pilose only laterad of frontogenal suture, sometimes entirely pilose or with only median vitta bare.

Thorax: nearly uniform in structure but sometimes with modifications. Scutum sometimes flattened on posterior half; scutellum sometimes with apical rim, sometimes with rounded apical notch and a pair of short slender preapical processes (Microdontinae), sometimes produced as a conical triangle (*Lepidomyia* Loew), or with a discal depression or with lateral or median tubercles or both (some Volucellini); notopleuron sometimes strongly enlarged (*Ornidia* Lepeletier et Serville) or projecting posteriorly over wing base (*Nausigaster* Williston). Anepisternum sometimes uniformly convex, not divided into a flat anterior and a concave posterior portion. Precoxal bridge absent; postcoxal bridge sometimes partly or completely developed (Figs 51–53); metasternum variable in development, each half ranging from a slender anterior and submedian sclerotized strip through various intermediate forms to a large unexcavated sclerite (Figs 46–47, 49–50).

Distribution of thoracic pile (and bristles, if present) varied, taxonomically important (Vockeroth 1969; Thompson 1972). Distinct bristles or spines sometimes present on anepisternum, notopleuron, postalar callus, prescutellar area of scutum, and scutellar margin; thorax otherwise with only fine pile. Prothorax with postpronotum and other sclerites pilose or bare. Scutum sometimes with transverse row of long erect pile near anterior margin; scutellum bare below or with posteroventrally or ventrally directed pile in

one or more rows near posterior margin of ventral surface (ventral scutellar fringe) (Fig. 41). Anepisternum always with convex posterior portion pilose, and with flattened anterior portion (if distinct) bare or with erect pile (Figs 76–79); katepisternum usually with distinct posterodorsal or ventral hair patches that are sometimes narrowly or broadly joined, rarely with one or both patches absent, sometimes with hairs also present anterodorsally or along anteroventral margin. Anepimeron with anterior section always pilose at least on upper half, with dorsal triangular section below wing base usually bare but sometimes densely pilose (Fig. 71), and with posteroventral section usually bare but sometimes partly or entirely pilose (Fig. 70–71); katepimeron pilose in all Syrphinae but pilose or bare in other subfamilies; meron usually bare but sometimes with pile situated anterior of and ventral to spiracle; laterotergite with only short dense microtrichia, with long erect pile only in some *Allobaccha* (Fig. 75). Metepisternum and metepimeron usually bare, but either sclerite sometimes with a few pili; postmetacoxal bridge, if present, bare; metasternum pilose or bare.

Wing (Figs 21–38) with characteristic venation, with much variation in minor details but always with these main features: vein C ending at apex or at vein  $R_{4+5}$ ; an unattached longitudinal vein called the spurious vein usually present, running most of length of cells *br* and  $r_{4+5}$ , although this vein absent in some species (e.g., *Syrirta flaviventris* Macquart); apex of vein M bent strongly forward near wing margin to end in vein  $R_{4+5}$  and forming apical crossvein; cell *cup* closed near wing margin. Pterostigma usually present, extending to apex of vein  $R_1$ , sometimes shortened or represented only by crossvein *Sc*, extending from near apex of veins *Sc* to  $R_1$ . Branches of veins R and M sometimes with short stump veins; upper surface of vein  $R_s$  usually with several long fine bristles, rarely bare; veins other than C bare. Wing membrane usually hyaline but sometimes darkened or with discrete dark markings, sometimes entirely covered with microtrichia but often without microtrichia on part or all of one or both surfaces; bare areas usually near base of wing but sometimes apical

part of wing or rarely entire wing, without microtrichia. Wing shape nearly uniform but anal lobe and alula sometimes much reduced or absent, especially in forms with petiolate abdomen. Calypter well-developed; lower lobe sometimes with erect fine to coarse hairs on upper surface (Fig. 40), with or without long marginal fringe. Plumule short to long, rarely absent, with short to long fringe.

Legs usually slender and simple but sometimes (especially in male) with coxa, trochanter, femur, tibia, or tarsus modified; hind coxa or trochanter sometimes bearing a spur (Fig. 93), spines, or a tubercle (Fig. 97); hind femur sometimes swollen or distorted, often bearing anteroventral or posteroventral preapical spines (Fig. 93) or a preapical flange (Fig. 94) or spur; tibia sometimes arcuate, bearing an apical spur (Fig. 97) or other-

wise modified; tarsus sometimes broadened and depressed or first taromere (especially on hindleg) sometimes strongly swollen; tarsal claws always curved and tapering to an acute apex except in male of *Ischiodon aegyptius* (Wiedemann).

Abdomen: extremely varied in shape; usually suboval (Fig. 92), sometimes short and broad, more frequently elongate and petiolate (Figs 89, 91), rarely broadened basally and slender toward apex. Margins of tergites usually curved uniformly downward laterally; in many Syrphinae tergites 2-5 or 3-5 with a submarginal longitudinal impression producing a marginated abdomen; in *Chrysotoxum* Meigen posterolateral angles of tergites often produced to give a serrated margin. Abdominal spiracle 1 in Microdontinae, Merodontini, and Pipizini situated in membrane

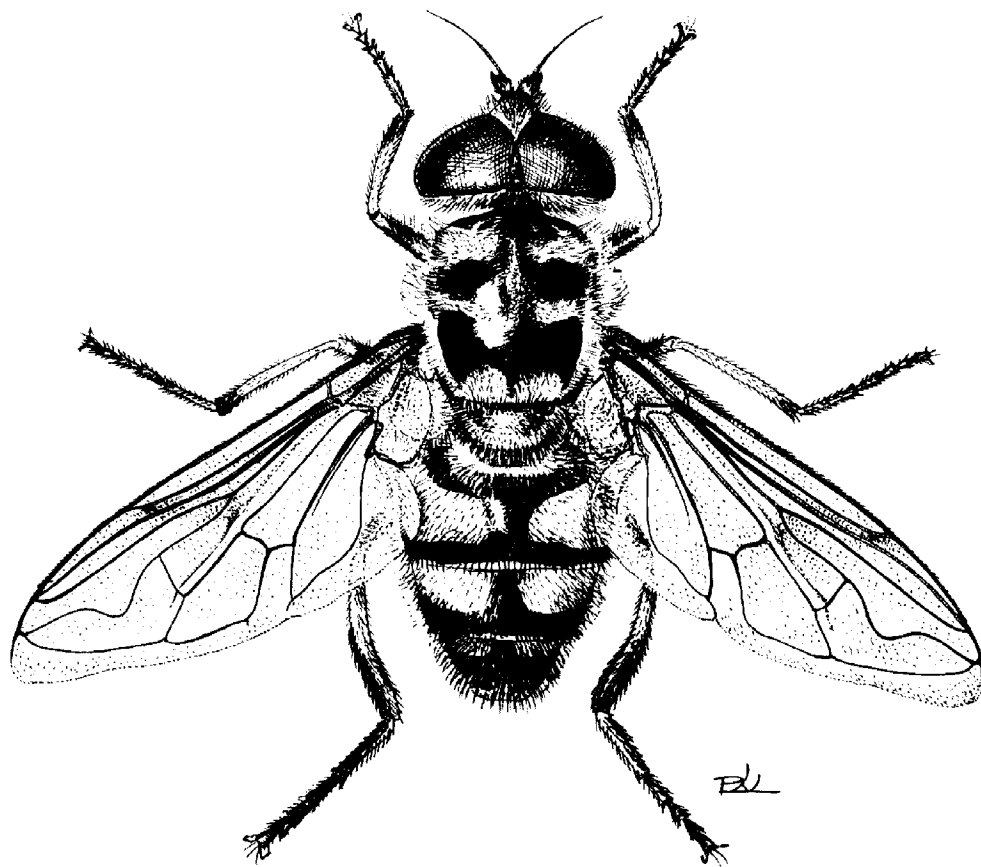


Fig. 5.2. *Myathropa florea* (Linnaeus), male.

between tergite 1 and sternite 1, in other groups in a sclerotized area that is apparently an anteroventral extension of tergite 1; spiracles 2-7 of both sexes situated in membrane between corresponding tergites and sternites.

Male with tergite 5 visible in Syrphinae, but in other subfamilies this tergite not visible externally. Sternites 1-5 usually well-developed, sometimes very slender, rarely with tubercles, keels, or other modifications; sternite 1 absent only in some species of *Sphagina* Meigen (Fig. 52). Terminalia (Fig. 61) rotated through 360°; segments 5 (or 6) to 8 rotated through 180°; segment 9 rotated through an additional 180°, so that sternite 8 lies immediately behind tergite 9 (epandrium); terminalia at same time flexed forward so that segment 9 normally lies in an asymmetric position below tergite 4 or 5 and surstyli and aedeagus are directed forward. Sternite 8 usually smoothly rounded externally, rarely with processes. Tergite 9 (epandrium) usually a hollow curved shell, open ventrally; a pair of usually weak and compressed but sometimes highly modified cerci set in a posterodorsal notch that is rarely (in most *Sphaerophoria* Lepeletier et Serville and in some *Ocyptamus* Macquart) closed posteriorly, so that cerci are thereby surrounded by tergite 9. Pair of articulated surstyli of varied shape at posterolateral angles of tergite 9; base of each surstylus with an internal apodeme projecting anteriorly below tergite 9; these apodemes fused medially, articulated anteriorly with anterodorsal angle of sternite 9 (hypandrium), and apparently representing sternite 10; sternite 10 in *Toxomerus* Macquart, some *Copestylus* Macquart, and some genera of Pipizini bearing a haired weakly to strongly sclerotized external process projecting posteriorly between surstyli. Terminalia of two markedly distinct types; in Microdontinae (Fig. 62) sternite 9 having infolded posterodorsal surface, and lacking articulated apical lobes; aedeagus elongate, swollen basally, unsegmented, tubular, without lateral or dorsal processes although often divided apically into two parallel tubes; aedeagal apodeme double or absent; ejaculatory apodeme small; sperm duct strongly sclerotized distally, with a swollen and spherical basal portion partly en-

closed by base of aedeagus, and with an elongate apical portion completely enclosed by aedeagus; terminalia of most species of Microdontinae almost identical. In Syrphinae and Eristalinae (Fig. 60) sternite 9 lacking infolded posterodorsal surface and having an articulated or fused process at each posteroapical angle called the paramere or superior lobe; aedeagus rarely elongate, never in the form of a simple elongate tube, strongly protruding or almost entirely enclosed within sternite 9, one- or two-segmented and often with distal segment forming an inflated semimembranous sac, usually with lateral or dorsal processes, and frequently with very complex sclerotization; aedeagal apodeme always present and single; sperm duct slender and membranous, but having at its proximal end a sclerotized ejaculatory apodeme that varies from very small to extremely large; terminalia of Syrphinae and Eristalinae extremely varied, offering excellent taxonomic characters at specific to tribal levels at least.

Female (see Hippa 1986) with at least tergites and sternites 1-5 exposed; sternite 5 sometimes partly withdrawn under sternite 4. Tergites and sternites 6-8 usually telescoped within preceding sclerites and weakly sclerotized; sometimes sternites 6, 7, or even 8 exposed and moderately to strongly sclerotized. Ovipositor (Fig. 63) usually slightly depressed to subcylindrical, rarely somewhat aciculate, generally ignored by taxonomists but with distinct specific differences in at least some species of *Toxomerus*, *Ocyptamus*, and *Orthonevra* Macquart. Three spermathecae present, small, apparently of little taxonomic significance, but so far not well investigated.

**Egg.** Nearly uniform in shape, elongate-ovoid, without apical or lateral processes. Surface sculpturing varied, providing important taxonomic characters in some groups. Chandler (1968) described and illustrated the eggs of many species (see also Kula (1993)).

**Larvae.** Distinguishable from larvae of other Diptera by the following combination of characters: fusion of posterior breathing tubes; dorsum of prothorax with longitudinal grooves; and anus

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sited on anterior margin of anal segment (Rotheray 1993; Rotheray and Gilbert in press).

First and second stages less well known than third stage. Third stage larva distinguishable by a pair of differentiated oval discs on dorsum of first abdominal segment which appear just before pupariation and through which protrude the respiratory horns of puparium (Hartley 1963). In some aphidophages and cerioidines, these discs and pupal horns are absent in which case third stage larvae are distinguishable by their larger size.

Larvae very variable in structure, habits and feeding mode. Within currently defined genera there is remarkable uniformity in these traits. Only in *Cheilosia* and *Volucella* do larvae vary in structure and feeding modes. *Cheilosia* include both mycophages and phytophages and in *Volucella* there are saprophages and entomophages.

Mycophages and phytophages (*Eumerus*, *Merodon*, *Cheilosia*, *Portevinia*) have mouthhooks and scrape and scoop food into the mouth. Entomophages (most *Volucella*, *Microdon* and Syrphinae + Pipizini) feed on larvae of social aculeates and soft-bodied Homoptera. Their mouthparts are varied in structure and are modified for tearing, piercing and gripping prey smaller than themselves. The mouthparts of the saprophages (Eristalinae including *Volucella inflata* but excluding groups mentioned above) are modified for filter-feeding microbes and lack mouth hooks. They exploit a wide variety of media including decaying tree sap, decaying heartwood and decaying vegetation. Morphologically all these groups are fairly distinct but grade into one another making it difficult to use larval characters to support supraspecific taxa. For example, *Ferdinandea* and *Rhingia* are intermediate in structure and habit between mycophages and saprophages and, *Volucella pellucens* and *Volucella bombylans* are intermediate in structure and habit between saprophages and entomophages.

Mycophages and phytophages usually have broader than tall papillae supporting the antennomaxillary organs; dorsal lips (region above the mouth and below the antennomaxillary organs) usually covered with setae and vestiture of vary-

ing types; mandibular lobes partially external to the mouth, (mandibular lobes are ridged sclerotised or non-sclerotized structures which are attached at one end, to the mandibular apodemes and, at the other, appear over the lateral margins of the mouth); a well developed, flexible collar around the mouth which gives it flexibility of movement and which is clear of vestiture; apex of mandibles ending in hooks which usually protrude from the mouth; lateral lips (oval-shaped projections on the lateral margin of the prothorax) little developed; thorax wedge-shaped, tapering and about as broad basally as it is long with a pair of short, deep grooves on the anterolateral margin (Figs 98–99); locomotory organs little differentiated and usually lacking prolegs and crochets (exceptions in *Eumerus*); anal segment asymmetrical with longer ventral than dorsal surface (viewed in profile) or anal segment truncate, consisting of an inclined plate with breathing tube in centre and fringed with setae.

Possibly many species have mixed feeding modes involving both mycophagy and phytophagy. Obligatory phytophages (many *Cheilosia* and *Portevinia*) are distinguishable from mycophages (*Eumerus*, *Merodon*, some *Cheilosia*) by the mandibular lobes which are black and sclerotized in the phytophages and pale and fleshy in the mycophages.

Saprophages have very uniform mouthparts varying only in relative size and shape (Fig. 101). The papillae supporting the antennomaxillary organs are longer than broad and often consist of a broader basal section; dorsal lip often lacking setae or with single clump of setae; mouth hooks absent and mandibles reduced and not protruding from mouth; mandibular lobes internal and expanded to coat entire inside of mouth; flexible collar reduced; lateral lips well-developed and projecting forward and coated in various types of setae varying from long and fine at tip to flattened at base; thorax as broad or broader than the abdomen, not tapering anteriorly and lacking deep antero-lateral grooves; anterior fold (region between the antennomaxillary organs and tips of longitudinal grooves on the dorsum of prothorax) as long as or longer than longitudinal grooves; anterior fold usually

coated in transverse rows of sclerotized spicules (exceptions are chryogasterines and *Myolepta*); feeding channel (depressed region behind mouth) down which pass filtered fluids from mouth present; mesothoracic prolegs with crochets usually present (barely developed in *Brachyopa*); prolegs with crochets present on abdominal segments 1–6; anal segment variously developed as in the long-tailed larvae of *Eristalis* and *Helophilus* (Fig. 100).

Some saproxylic saprophages (e.g., *Brachypalpus*, *Chalcosyrphus*, *Callicera*, *Spilomyia*, *Milesia*) have varying arrangements of hooks on the thorax which facilitate movement and protect the thorax (Rotheray 1991) (Fig. 102). Anterior spiracles in some long-tailed larvae (*Eristalis*, *Myathropa*, *Helophilus*) are retractable into invaginated pockets on the integument.

Entomophages have varied mouthparts. In general thorax is narrower than abdomen, longer than basally broad, highly retractile and flexible (Fig. 103); lateral lips reduced; and feeding channel absent. The papillae supporting the antennomaxillary/organs are elongate but usually lack a broad basal region. The dorsal lip is developed into a tapered fleshy organ with a ventral groove along which project the mandibles. The mandibular lobes are developed inside the mouth and variable: in the facultative entomophages (*Volucella bombylans* and *V. pellucens*), they consist of sclerotized ridges each of which terminates in a small hook, but these ridges are absent in the obligatory entomophage, *V. inanis*; in *Microdon* ridges are also absent and mandibular lobes are fused with the mandibular sclerite to form a pair of tong-like structures with serrated margins; in the aphidophages (Syrphinae + Pipizini) fused mandibular sclerite/mandibular lobe is spike-like and lacks serrations; in both *Microdon* and the aphidophages each mandibular sclerite can move independently of the other; in *V. inanis*, *Microdon* and the aphidophages the labial sclerite is also developed. In these taxa the labial sclerite is extended forward. In *V. inanis* it is hook-like in shape and in *Microdon* and the aphidophages it projects forward to the tip of the head skeleton. In *Volucella* mesothoracic prolegs are present but, in comparison, in the sapro-

phage, *V. inflata*, they are reduced and the anterior fold has a few large spicules not arranged in transverse rows. These structures are absent in *Microdon* and the aphidophages. However, in these taxa the lateral lips terminate in a pair of hook-like projecting organs which are black and sclerotized in the aphidophages. In *Microdon* the mesothorax and metathorax possess a pair each of similar fleshy projections which close over the front of the thorax as it retracts thereby affording protection. In the aphidophages (Syrphinae + Pipizini) the ventral surface of the thorax has a differentiated surface sculpture that protects the thorax when moving and searching for food.

In entomophages, when resting the front of the larva is the anterior margin of the metathorax. In *Microdon* the metathorax is fixed in this position with the mesothorax and prothorax hidden underneath. Locomotory mechanisms vary in the entomophages. In *Volucella* prolegs and crochets are present. In *Microdon* the ventral surface is flat and lacks prolegs and crochets. The larva can contract each side of the body independently, allowing it to turn in a narrow radius without lifting itself up so that it appears to glide over the substrate. In the aphidophages prolegs and crochets are absent. These larvae grip the substrate with meniscus forces from fluids emitted by the anus and sticky saliva, and they use a grasping bar at the tip of the anal segment to prevent slippage at the start of movement.

Aphidophages have cryptic colour patterns involving pigments in the haemolymph and fat bodies, with fat bodies arranged in stripes, chevrons, dots and other patterns combined with aggregations of spicules on the integument and fleshy projections (Rotheray 1986).

**Puparium.** Pupation occurs within the contracted and eventually hardened larval skin and is usually stuck to the substrate by secretions from the anus. Pupal spiracles present in all taxa except most Syrphinae (e.g., present in *Melanostoma*, *Xanthandrus*, *Platycheirus*, *Xanthandrus*, *Platycheirus* and *Baccha*, absent in rest) and some cerioidines. Pupal spiracles varying greatly in length, shape and nature of pores and protruding through dorsum of abdominal segment 1. Eclo-

sion of adult by forcing open 2 or 3 opercula formed from thoracic and first abdominal segments.

**Biology and behaviour.** The adults are among the most abundant and conspicuous of Diptera. Most, if not all species are able to hover motionless in flight or to move in various directions. Most species are diurnal and very active. Some species (*Episyrphus balteatus*) are migratory. All Syrphinae and Eristalinae probably visit flowers and feed on pollen and nectar. They are significant pollinators of many plants, but their role as such has not been studied as much as for bees. This exposed feeding situation is probably responsible for their mimicry of aculeate Hymenoptera, and mimicry is more frequent and better developed in the Syrphidae than in any other family of Diptera. The Microdontinae are rather weak fliers and do not seem to move far from the larval habitat. Nevertheless many microdontine species mimic Hymenoptera.

Three main types of larval feeding mode are known: mycophagy/phytophagy (*Eumerus*, *Merodon*, *Cheilisia* and *Portevinia*); entomophagy (*Volucella* (except *V. inflata*), *Microdon* and Syrphinae + Pipizini); and saprophagy (remaining syrphids including *V. inflata*). Nothing however is known of larval biology in Peleco-cina. Of these feeding mode groups the mycophage/phytophages are least well known. Most *Eumerus* are mycophages within pockets of decay in live plants. *Merodon* species may have mixed feeding strategies involving mycophagy and phytophagy, as do some *Cheilisia* (e.g., *C. paganus* and *C. illustrata*). Other *Cheilisia* are phytophagous (e.g., *Cheilisia fraterna* in *Cirsium* and *Cheilisia fasciata* in *Allium*). A few *Cheilisia* feed on pine cambium accessed via wounds through the bark e.g., *Cheilisia morio* (Rotheray 1993).

*Volucella* larvae are either saprophages in exuded tree sap (*V. inflata*) or facultative entomophages feeding on pollen, comb material and live or dead larvae in nests of social aculeates (*V. bombylans*, *V. pellucens*) or are obligatory brood predators (*V. inanis* and *Microdon* are brood predators of ants). Syrphine and pipizine larvae

are predators of mostly soft-bodied Homoptera but some species feed on immature Thysanoptera, Coleoptera or Lepidoptera. Syrphine and pipizine larvae have, unlike most other syrphids, cryptic colour patterns and behaviours (Rotheray 1986).

Saprophages exploit wet or moist conditions in a wide range of habitats. Many taxa are associated with decaying tree sap in sap-runs and under bark of fallen wood (*Brachyopa*, *Ceriana*, some *Chalcosyrphus*, *Ferdinandea*, *Psilota*, *Sphingina* some *Xylota*). Another important habitat is decaying wood in rot-holes, tree roots and fallen wood (*Xylota* (*Brachypalpoides*), *Brachypalpus*, *Blera*, *Caliprobola*, *Callicera*, *Criorhina*, *Lejota*, *Mallota*, *Milesia*, *Myolepta*, *Spilomyia*, *Temnostoma* and some *Xylota*). Other taxa occur in decaying vegetation in pools, bogs and wet compost of various types (*Chrysogaster*, *Lejogaster*, *Neoscia*, *Orthonevra*, some *Xylota* and most long-tailed or rat-tailed larvae, *Eristalis*, *Helophilus*, *Sericomyia*, etc.). *Rhingia* occurs in dung. Records from dung are also known for *Tropidia*, *Syritta* and some long-tailed larvae e.g., *Eristalis*.

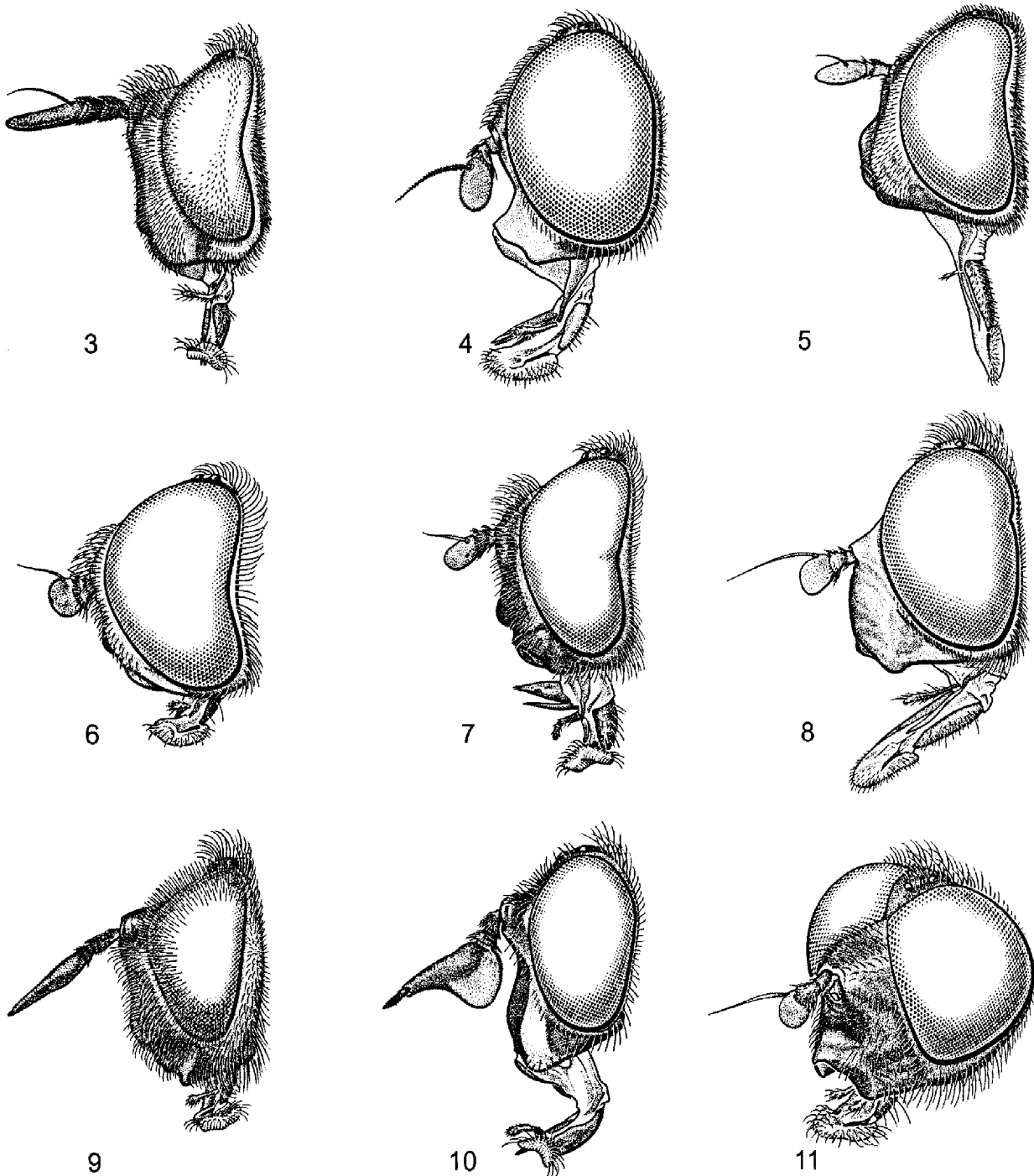
Mycophages and phytophages associated with commercially grown plants may achieve pest or nuisance status e.g., *Eumerus strigatus*, *Eumerus tuberculatus*, and *Merodon equestris* in *Narcissi* or *Cheilisia vulpina* in artichokes (Brunel and Cadou 1994). Other species may be useful in weed control e.g., *Cheilisia corydon* (Harris) was introduced from Europe to the USA to control *Cirsium*).

Aphidophages are probably important in controlling their prey on cultivated plants but their effectiveness is little understood. This is partly because they feed at night and often move away from aphid colonies during the day and so tend to be underestimated.

Many saproxylic saprophages are rare and endangered and are subjects of active conservation e.g., *Blera fallax* and *Hammerschmidtia ferruginea* in Britain and may be important indicators of woodland quality elsewhere (Speight 1986). Other saprophages such as many long-tailed larvae are useful as indicators of water quality and have potential for cleaning polluted waters. Larvae of a few Eristalini and *Syritta* have been

known to cause intestinal myiasis in man, but these occurrences are rare (James 1948). Larvae have been used to re-cycle wastes and as protein sources (Larde 1989).

**Classification and distribution.** The higher classification of the Syrphidae is in a state of flux. The traditional classification is largely based on adult characters. Recent work on larval charac-



Figs 5.3–11. Adult Syrphidae, male heads, lateral view (except 11 lateroblique). 3: *Chrysotoxum derivatum* (Walker); 4: *Sphagina* (S.) *keeniana* Williston; 5: *Pseudodoros clavatus* (Fabricius); 6: *Baccha elongata* (Fabricius); 7: *Melanostoma melinum* (Linnaeus); 8: *Tropidia quadrata* (Say); 9: *Callicera erratica* (Walker); 10: *Pelecocera pergandei* (Williston); 11: *Chalcosyrphus* (*Chalcosyrphus*) *depressus* (Shannon) (after Vockeroth and Thompson 1987).



ters has generated different classifications. While these larval studies do support many of the same clades that the adult characters define, the most recent analysis based on larval characters is fundamentally different. This analysis, for example, revealed the genus *Volucella* to be polyphyletic, with both major clades of flower flies arising from within it. Thus, clearly the traditional classification based on adult characters alone can not be maintained. However, until a comprehensive analysis is done on a combined data set of both adult and larval characters, we have accepted the traditionally defined groups as that is how the literature and knowledge is currently organized. On the basis of adult characters, three subfamilies and 14 tribes are recognized (Microdontinae, Syrphinae (Bacchini, Paragini, Syrphini and Toxomerini) and Eristalinae (Pipizini, Spheginobacchini, Rhingiini, Volucellini, Callicerini, Eristalini, Brachyopini, Cerioidini, Eumerini, Milesiini)). Our generic classification largely follows that used in the Palaearctic Diptera Catalogue (Peck 1988), however, some groups are reduced to subgeneric rank. Other changes in respect to the catalog treatment are covered elsewhere (Thompson, in press).

The family is nearly world wide in distribution. Flower flies occur almost everywhere there is land. They are absent only from Antarctica and remote oceanic islands, such as Hawaii and many subantarctic islands. However, many species have been transported by human agency so that Hawaii now has 16 residents species and Easter Island two.

Of the 14 tribes of Syrphinae and Eristalinae recognized, 12 are widespread, occurring in most major zoogeographical regions. However, the Toxomerini, with the single genus *Toxomerus*, is a New World group, and Spheginobacchini, with the single genus *Spheginobaccha* is restricted to southern Africa and the Orient.

The distribution of most genera, unlike that of most tribes, is markedly restricted. There are a few exceptions, due to either human introductions or taxonomic artifact. *Eristalis* (*Eristalis*), *Eristalinus* (*Lathyrophthalmus*), *Eumerus* and *Syrirta* are now cosmopolitan due to the spread of a few Old World synanthropic species. *Micro-*

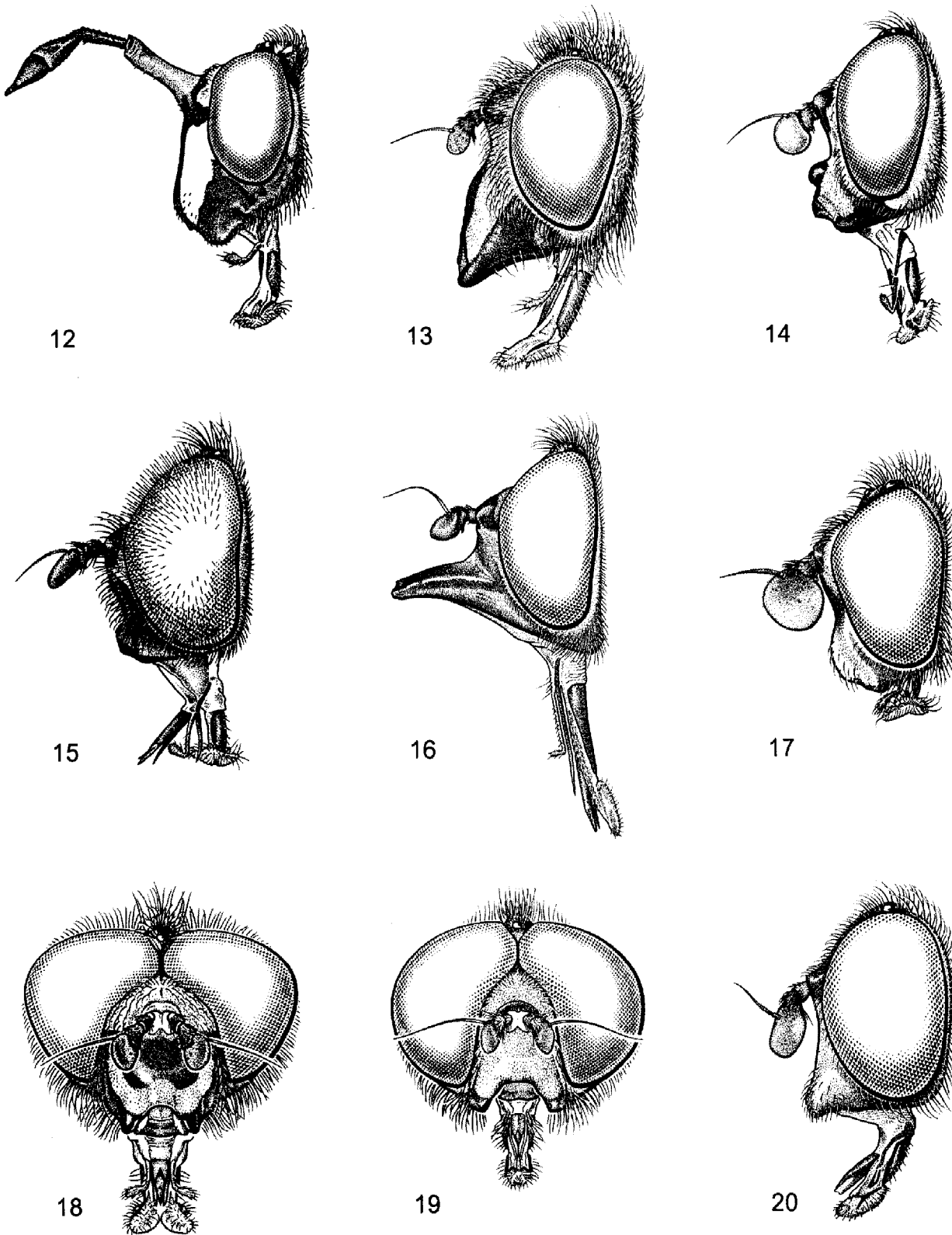
*don* Meigen, as currently recognized, is nearly world wide in distribution and very diverse in appearance; it may eventually be divided into several genera. All species of Cerioidini mimic wasps; as a result, the genera recognized here, some of which are nearly world wide, may be artificial groups based on similarities resulting from mimetically induced convergence. Only two genera are truly cosmopolitan (*Allograpta* and *Xanthandrus*). *Paragus* (*Pandasyopthalmus*) and *Milesia* are found in all biotic regions, but are absent from South America.

Most genera are markedly restricted to the Holarctic, the Neotropical, or the Palaeotropical regions. Rarely is a genus well-developed in two of these regions and even more rarely is a genus represented more than intusively in all three regions.

About 188 genera of Syrphidae are recognized and about 6,000 species have been described. Approximately 1,800 species in 107 genera and 32 non-typic subgenera are Palaearctic. Thirty-six of these genera are predominantly Holarctic in distribution. In a few cases these genera have a subgenus (as now defined) with its greatest development elsewhere. *Chalcosyrphus* (*Neplasp* Porter) is almost entirely Neotropical, *Chalcosyrphus* (*Hardimyia* and *Neploneura* Hippa) are Australian, and *Paragus* (*Pandasyopthalmus* Stuckenberg) is predominantly Palaeotropical. Together, these north temperate genera contain more than half the Palaearctic species. Some 110 species are Holarctic in distribution. The largest genus of Syrphidae is *Cheilosia* with 387 species, however, the New World genera *Ocyptamus* (297 species) and *Copestylum* (308 species) will probably be much larger as many undescribed species are known.

Only 14 genera are restricted to the Palaearctic region (*Asiodidea*, *Caliprobola*, *Ischyroptera*, *Lejogaster*, *Liochrysogaster*, *Macropelecoce- ra*, *Macrozelima*, *Pipizella*, *Platynochaetus*, *Portevinia*, *Primoceroides*, *Psarochilosia*, *Psarus*, *Taeniochilosia*).

Beyond the north temperate distribution pattern and the endemic groups, there are two other major patterns which account for the majority of flower fly biodiversity: the New World endemics



Figs 5.12–20. Adult Syrphidae, male heads. 12–17: lateral view: 12: *Ceriana abbreviata* (Loew); 13: *Lejops* (*Arctosyrphus*) *willingii* (Smith); 14: *Myolepta varipes* Loew; 15: *Psilota thatuna* Shannon; 16: *Rhingia nascia* Say; 17: *Chamaesyrphus willistoni* Snow. 18–19: anterior view: 18: *Brachypalpus oarus* (Walker); 19: *Xylota barbata* Loew. 20: *Neosciasia metallica* (Walker), lateral view (after Vockeroth and Thompson 1987).

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and Palaeotropical endemics. The most distinctive group of genera are the 10 genera that are mainly Neotropical with extensions into the southern Nearctic. This pattern accounts for probably quarter of the world syrphid diversity. The largest of these genera are *Copestylum*, *Toxomerus*, *Ocyptamus*, and *Palpada*. The Palaeotropical genera which have their greatest diversity in the Afrotropical and Oriental regions, but have some species which extend into the southern areas of Palearctic and western portions of the Australian region, include *Meliscaeva*, *Eumerus*, *Graptomyza*, *Mesembrius*, *Milesia* and *Melanostoma*.

The identification of flower flies is not always easy as there are a number of very similar species and no comprehensive reference works. There are many published keys, some are worse than nothing, such as those of Violovitsh, whereas others, while obsolete, are still very useful, such as those of Schiner. The best and most recent keys for each taxon are cited. The best way to learn how to identify flower flies is to get a guide with colour pictures, such as Stubbs and Falk (1983) or Torp (1984). While these guides may not cover all the species of one's region, they will include the common one. So, first get to know the common species, making sure that these species can be readily identified using the local faunistic works. Then the rarer species can be understood. Finally, one should not attempt to describe new species without consulting with experts that know the whole Palearctic fauna. More synonyms have been created among the flower flies than any other group of Diptera (except the tachnids, where Robineau-Desvoidy described the common tachinid (*Phryxe vulgaris* (Fallén) 245 times (Coquillett 1910), because even the experts have thought they had new species, when they had instead overlooked already named ones.

The literature on taxonomy and biology of both the adult and larva is extensive, only the key references and except for a few critical extralimital one only those that apply to Palearctic region are cited below. Gilbert (1986) provides a popular introduction to the family. There is a serial, *Volucella*, devoted just to flower flies and a news-

letter, *Hoverfly Newsletter*, published in conjunction with the *Dipterists Forum*. Up-to-date data on flower fly names and references can be found at the Diptera World-Wide-Web site at the Systematic Entomology Laboratory, USDA (<http://www.sel.barc.usda.gov>).

**Morphology.** Speight 1987 (adult); Nayar 1964a (head); Hippa 1986 (female genitalia); Metcalf 1921, Zumpt and Heinz 1949, Nayar 1965 (male genitalia); Nayar 1964b (thorax); Boyes et al. 1971, 1980 (Chromosomes); Conn 1972 (genetics); Andersson 1970a, Knutson 1971 (melanism); Gilbert 1985c (size and shape variation).

**Immature stages.** Chandler 1968, Kula 1993 (eggs); Heiss 1938 (terrestrial spp.); Alsterberg 1934 (aquatic spp.); Schneider 1969, Rotheray and Gilbert 1989 (aphidophagous spp.); Rotheray 1986 (colour, shape and defence); Dixon 1961, Hartley 1961, Goeldlin 1974, Rotheray 1993 (descriptions); Hartley 1963, Roberts 1970, Wichard and Kommick 1974 (morphology).

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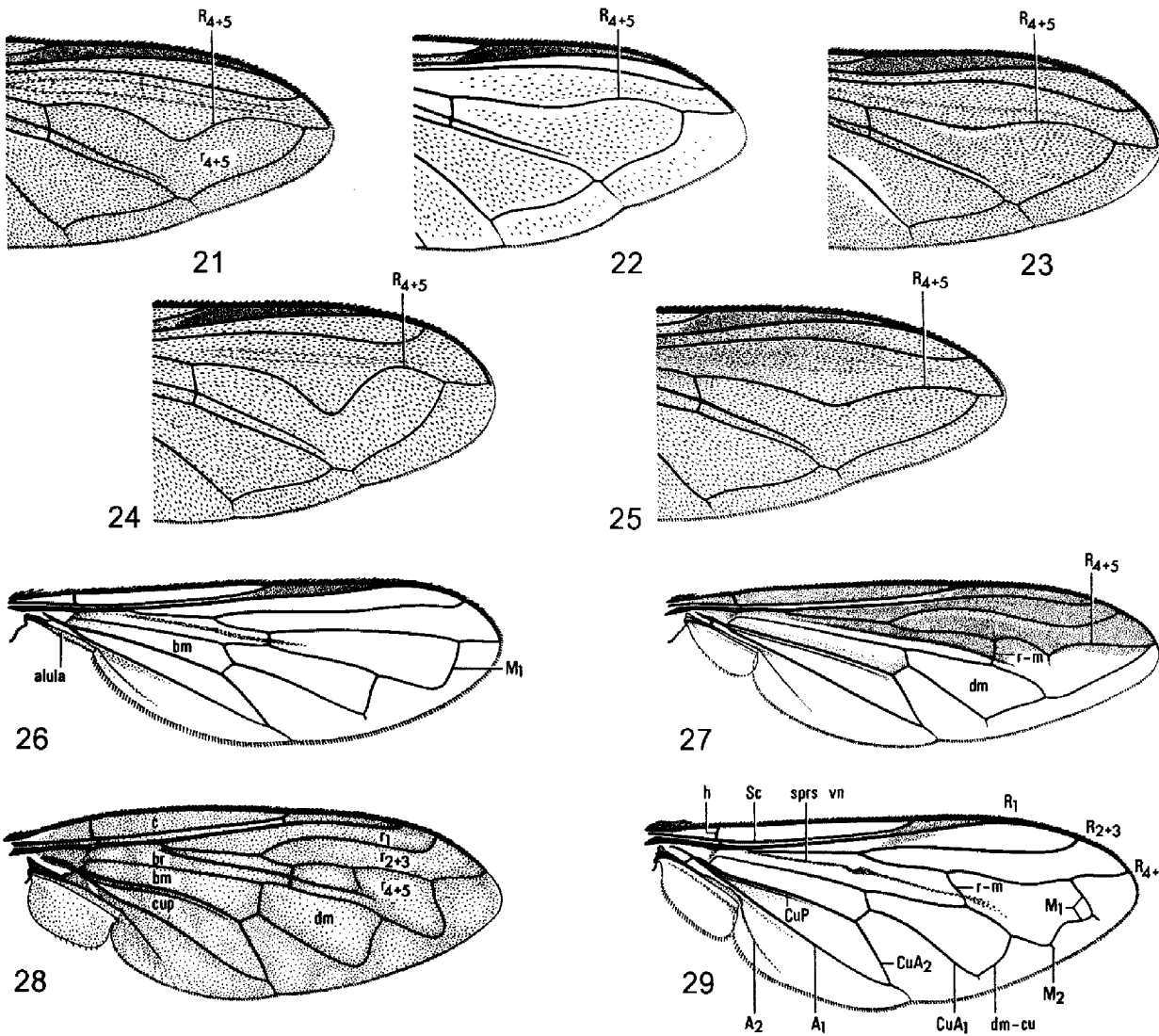
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**Taxonomy. Classification:** Hull 1949, Vockeroth 1969, Thompson 1969, 1972, Shatalkin 1975, Hippa 1978a, Rotheray and Gilbert 1989, 1998. **Catalogues:** Kertész 1910 (world); Wirth et al. 1965 (Amer. n. Mexico); Thompson et al. 1976 (Neotropics); Knutson et al. 1975 (Oriental); Smith and Vockeroth 1980 (Afrotropical); Peck 1988 (Palearctic); Thompson and Vockeroth 1989 (Australian-Oceanian).

**Monographs:** Schiner 1861-62 (Europe); Sack 1928-32 (Palearctic); Séguy 1961 (western Europe); Goot 1981 (northwestern Europe); Staczelberg 1970, 1988 (European USSR).

**Regional lists and studies:** Frey 1945 (Azores); Verlinden and DeClerck 1987 (Belgium); Baez 1977 (Canary Is.); Dušek and Láska 1987a (Czechoslovakia); Lundbeck 1916, Torp 1984 (Denmark); Shaumar and Kamal 1977, 1978 (Egypt); Speight 1978 (Eire); Hackman 1980 (Finland); Speight 1993, 1994 (France); Röder 1990 (Germany); Verrall 1901, Stubbs and Falk 1983 (Great Britain); LeClercq 1958 (Greece); Andersson 1967 (Iceland); Shiraki 1930, 1968 (Japan); Speight and Lucas 1992 (Liechtenstein); Frey 1949 (Madeira); Dirickx 1994 (Mediterranean area); Claussen 1989 (Morocco); Ban-



Figs 5.21-29. Adult Syrphidae, wings. 21: *Didea fuscipes* Loew; 22: *Scaeva pyrastris* (Linnaeus); 23: *Eupeodes (Lapposyrphus) lapponicus* (Zetterstedt); 24: *Dideomima coquilletti* (Williston); 25: *Eriozona (Megasyrphus) erratica* (Linnaeus); 26: *Neoascia distincta* Williston; 27: *Ceriana abbreviata* (Loew); 28: *Microdon cothurnatus* Bigot; 29: *Eumerus strigatus* (Fallén) (abbreviation: sprs vn: spurious vein) (after Vockeroth and Thompson 1987).

kowska 1963 (Poland); Suster 1959, Bradescu 1991 (Romania); Violovitsh 1983, 1986 (Siberia); Gil Collado 1930 (Spain); Bartsch 1995 (Sweden); Maibach et al. 1992 (Switzerland); Glumac 1972 (Yugoslavia).

*Nomenclature:* Thompson 1980, 1981, 1988; Smart 1944, Sabrosky 1952, 1954 (Meigen 1800 names); Sabrosky 1998 (family group names); Thompson and Pont 1993 (Musca names); Thompson et al. 1982 (Linnaean names); Pont 1995 (Verrall and Collin types).

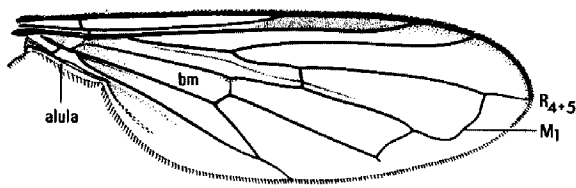
Fossil Syrphidae, apparently referable to 38 genera of all three subfamilies, are known from the Eocene, Oligocene, and Miocene. Hull (1945) gave an excellent review of most fossil species,

and Evenhuis (1995) provided a complete catalog to the fossil taxa. The majority of the species are known from Baltic amber (32 species); the others are from sedimentary deposits from western North America and Europe (55 species). Undescribed species are also known from Cretaceous resins in Siberia and Oligocene/Miocene resins in Hispaniola. Twenty-seven species are assigned to extant genera (16), which do not differ markedly from living Syrphidae, the others (61) belong to extinct genera. Because of many changes in classification and the use of many additional taxonomic characters since Hull's study, the available fossil material needs to be critically reexamined.

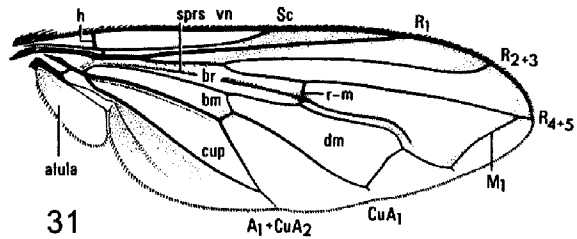
### KEYS TO GENERA

#### Adults

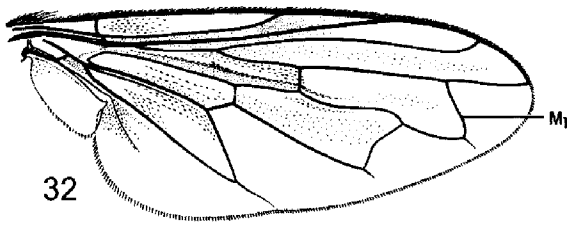
1. Postpronotum bare (Fig. 76). Head posteriorly strongly convex and closely appressed to thorax so that postpronotum is partly or entirely hidden. Male abdomen with tergite 5 visible in dorsal view and varying in form of a subquadrate or subtriangular to short transverse sclerite (Figs 57–58) 8
  - Postpronotum pilose (Fig. 79). Head posteriorly less strongly convex; postpronotum clearly exposed. Male abdomen with tergite 5 not visible in dorsal view (Fig. 59) 2
2. Antenna with terminal stylus (Figs 9–10, 12, 66–68) or thick apical arista 67
  - Antenna with dorsal arista (Figs 3–8, 13–20, 64–65, 69, 80–88), with arista thin and usually basal, never at apex 3
3. Vein  $R_{4+5}$  moderately to strongly sinuate (Figs 21, 24, 35–38) ~~80~~<sup>75</sup>
  - Vein  $R_{4+5}$  straight or nearly so, not sinuate (Figs 22–23, 26–28, 30–32, 34) 4
4. Arista plumose, with pile (rays) at least 3 times as long as basal diameter of arista (Figs 69, 80, 85) 103
  - Arista bare or pubescent, with pile never more than twice as long as basal diameter of arista (Figs 3–8, 13–20) 5
5. Eye bare (Figs 4, 8, 11, 13–14, 16–20). Crossvein R-M usually oblique, beyond middle of discal cell, frequently strongly oblique and extending to outer third of discal cell (Figs 27, 33); if crossvein located above middle fifth (0.4–0.6) of discal cell, then thorax without bristles. Metasternum often strongly developed 139



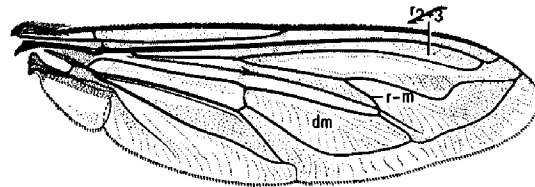
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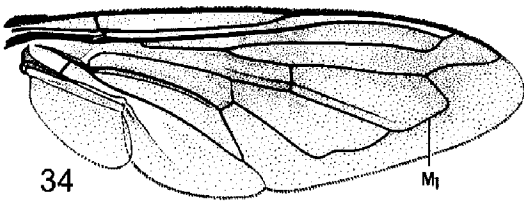
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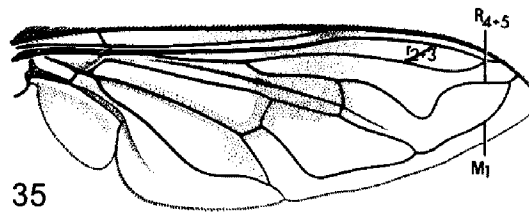
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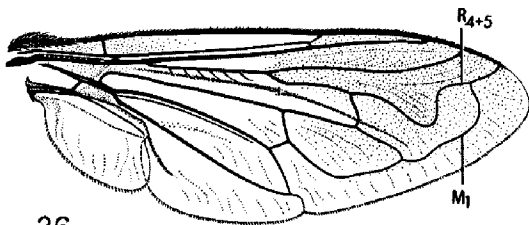
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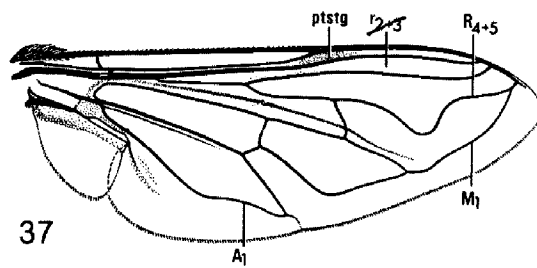
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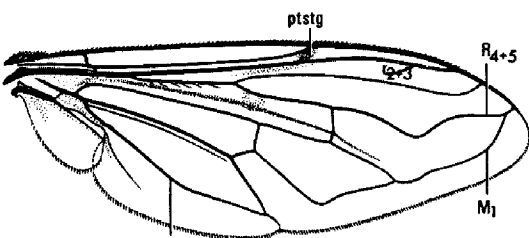
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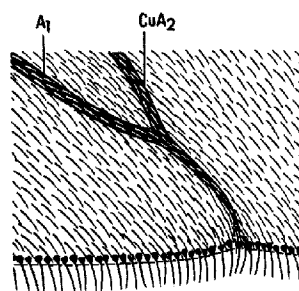
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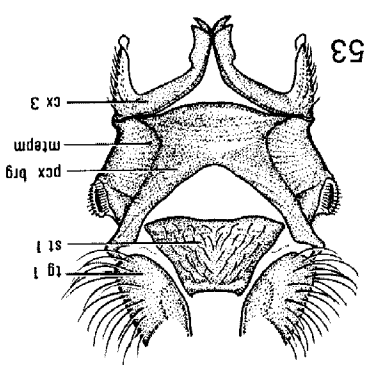
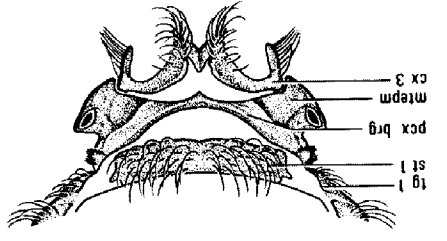
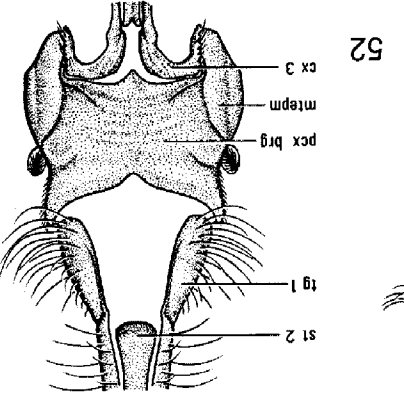
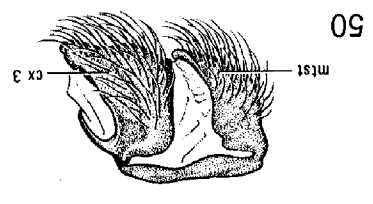
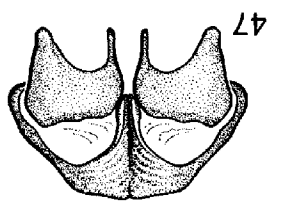
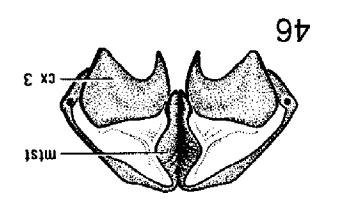
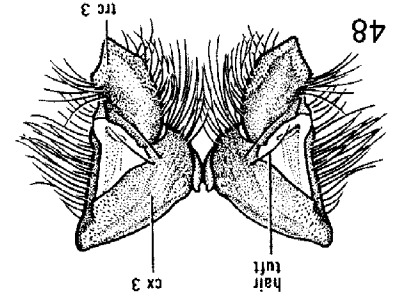
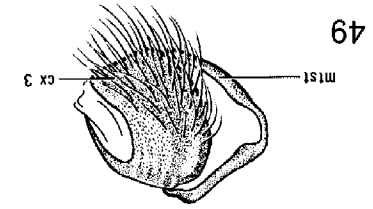
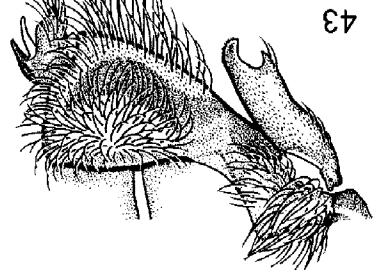
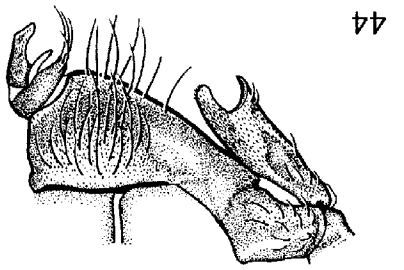
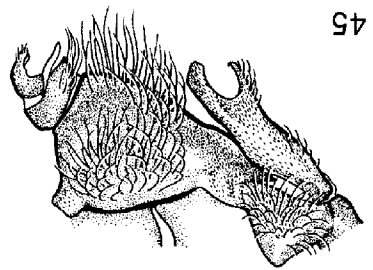
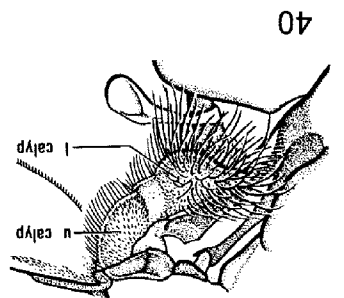
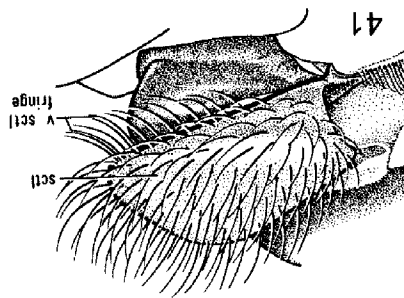
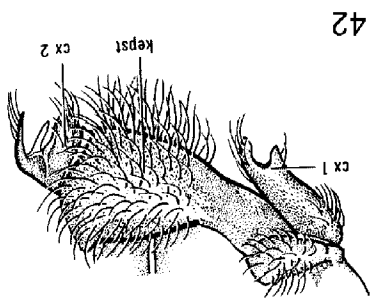
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Figs 5.30–39. Adult Syrphidae, wings. 30: *Sphegina (S.) keeniana* Williston; 31: *Brachyopa (Brachyopa) notata* Osten Sacken; 32: *Orthonevra pulchella* (Williston); 33: *Milesia virginiensis* (Drury); 34: *Volucella bombylans* (Linnaeus); 35: *Eristalis (E.) tenax* (Linnaeus); 36: *Merodon equestris* (Fabricius); 37: *Helophilus latifrons* Loew; 38: *Parhelophilus laetus* (Loew); 39: *Meliscaeva cinctella* (Zetterstedt) (abbreviations: ptstg: pterostigma, sprs vn: spurious vein) (after Vockeroth and Thompson 1987).

- Eye pilose (Figs 9, 15, 83, 85) or bare. If eye bare, then crossvein R-M usually perpendicular, usually before middle of discal cell, never strongly oblique nor extending to outer third or more of discal cell (Figs 26, 30, 34); if crossvein located above middle fifth of discal cell, then thorax with distinct bristles. Metasternum never strongly developed 6
6. Antenna elongate, with scape and usually also basoflagellomere more than 2.5 times as long as wide (Fig. 82). Anterior anepisternum pilose. Postmetacoxal bridge narrow but complete (Fig. 51). Vein  $R_{4+5}$  often with an appendix into cell  $r_{4+5}$  (Fig. 28). Eye bare 66
- Antenna usually short; scape usually at most twice as long as wide; basoflagellomere usually rounded or oval. If scape more than twice as long as wide, postmetacoxal bridge absent. Anterior anepisternum pilose or bare. Postmetacoxal bridge usually absent or incomplete, but if present then broad (Figs 52–53). Vein  $R_{4+5}$  never with an appendix into cell  $r_{4+5}$  7
7. Oral margin notched anteromedially; facial groove elongate, not forming a small round pit (Fig. 84); eye and face pilose or bare. Subscutellar fringe present or absent 112
- Oral margin evenly rounded, not notched anteromedially; facial groove reduced to a pit (Fig. 83); eye and face densely pilose. Subscutellar fringe present 61
8. Antenna elongate, sometimes longer than head; basoflagellomere at least three times as long as broad; scape and pedicel often longer than broad (Fig. 3). Abdomen strongly convex dorsally, strongly margined, usually with posterolateral angles of tergites projecting  
**Chrysotoxum** Meigen  
71 spp.; widespread; Violovitsh 1974a.
- Antenna short, shorter than head; basoflagellomere at most twice as long as broad; scape and pedicel not longer than broad. Abdomen variable but without posterolateral angles of tergites projecting 9
9. Calypter with lower lobe pilose, especially on posteromedial portion (Fig. 40)  
**Syrphus** Fabricius  
22 spp.; widespread.
- Calypter bare 10
10. Anterior anepisternum bare 14
- Anterior anepisternum pilose at least posterodorsally (Figs 76–78) 11
11. Wing margin without such maculae. Hind coxa with tuft of pile at posteromedial apical angle (Fig. 48). Eye bare or pilose. Metasternum bare. Abdomen oval **Parasyrphus** Matsumura  
19 spp.; widespread, including Arctic; Mutin 1990; Speight 1991a.
- Wing margin with a series of minute closely spaced black maculae on posterior margin (Fig. 39). Hind coxa without such a tuft. Eye bare. Abdomen suboval to petiolate 12
12. Metasternum pilose **Episyrphus** (**Episyrphus** Matsumura)  
3 spp.; widespread including North Africa.
- Metasternum bare 13



13. 14. 15. 16. 17. 18. 19. 20. 21. 22. 23. 24. 25. 26. 27. 28. 29. 30. 31. 32. 33. 34. 35. 36. 37. 38. 39. 40. 41. 42. 43. 44. 45. 46. 47. 48. 49. 50. 51. 52. 53.



Figs 5 ventra trophe chanta Spheg

13. Abdomen oval to parallel-sided, never petiolate; tergite 2 always less than twice as long as its apical width; metepisternum bare; anterior anepisternum generally pilose **Meliscaeva** Frey  
3 spp.; widespread including North Africa.
- Abdomen petiolate; tergite 2 more than 6 times as long as its apical width; metepisternum pilose ventrad to spiracle; anterior anepisternum with a single row or patch of piles apicoposteriorly (Fig. 76) **Episyrrhus** (Asiobaccha) Virolvitsh  
1 sp., *E. (A.) nubilipennis* (Austen); China and Far East.
14. Abdomen parallel-sided (Fig. 90) to oval, never distinctly petiolate 19
- Abdomen elongate, strongly petiolate (Figs 89, 91); 2nd tergite narrower than 3rd tergite 15
15. Postpronotum and/or anterior anepisternum pilose; laterotergite dorsally with a patch of long pile (Figs 75, 78–79) **Allobaccha** Curran  
1 sp., *A. apicalis* (Loew); China and Far East.
- Postpronotum, anterior anepisternum, and laterotergite all bare 16
16. Face produced rather strongly forward on ventral half (Fig. 5) **Pseudodoros** Becker  
1 sp., *P. nigricollis* Becker; Egypt.
- Face not at all produced forward, straight with a weak tubercle (Fig. 6) 17
17. Abdomen greatly elongate, narrow; 2nd and 3rd tergites much narrower than scutellum (Fig. 89) **Baccha** Fabricius  
12 spp.; widespread; Virolvitsh 1976a.
- Abdomen shorter, broader; 2nd tergite as broader or broader than scutellum; 3rd tergite always broader than scutellum (Fig. 91) 18
18. Arista plumose, with pile more than twice as long as arista width; face black **Platycheirus** (Spazigaster) Rondani  
2 spp.; Europe to Pamir.
- Arista bare; face yellow **Doros** Meigen  
3 spp.; widespread; Speight 1988.
19. Face and scutellum entirely black in background colour. Abdomen without marginal sulcus. Metasternum bare. Eye bare 52
- Face or scutellum or both at least partly yellow or yellowish brown in background colour, both never entirely black. If in doubt, eye pilose. Abdomen, metasternum, and eye variable 20

Figs 5.40–53. Adult Syrphidae, details of thorax and base of abdomen. 40: *Syrphus ribesii* (Linnaeus), dorsal surface of ventral calypter. 41: *Allograpta obliqua* (Say), posterolateral view of scutellum. 42–45: kataposternum and associated structures, lateral view: 42: *Xanthandrus mexicanus* Curran; 43: *Epistrophe (E.) grossulariae* (Meigen); 44: *Epistrophe (Epistrophe) emarginata* (Say); 45: *Eupeodes (E.) americanus* (Wiedemann). 46–47: metasternum, ventral view: 46: *Melanostoma mellinum* (Linnaeus); 47: *Platycheirus (P.) quadratus* (Say). 48: *Parasyrphus tarsatus* (Zetterstedt), hind coxa and trochanter, posterior view. 49–50: metasternum and hind coxa, lateral view: 49: *Cynorhinella longinasus* Shannon; 50: *Tropidia quadrata* (Say). 51–53: postmetacoxal bridge and base of abdomen, ventral view: 51: *Microdon cothurnatus* Bigot; 52: *Sphegina (Asiosphegina) petiolata* Coquillett; 53: *Polybiomyia tounsendi* (Snow) (abbreviations: l calyp: dorsal calypter, kepst: kataposternum, mtepm: metathoracic epimeron, mtst: metasternum, pcx brg: postmetacoxal bridge, sctl: scutellum, st: sternite, tg: tergite, trc: trochanter: u calyp: ventral calypter, v sctl fringe: subscutellar fringe) (after Vockeroth and Thompson 1987).